

Weaving the Quality Thread in Lockheed Martin's Digital Tapestry

26 October 2016

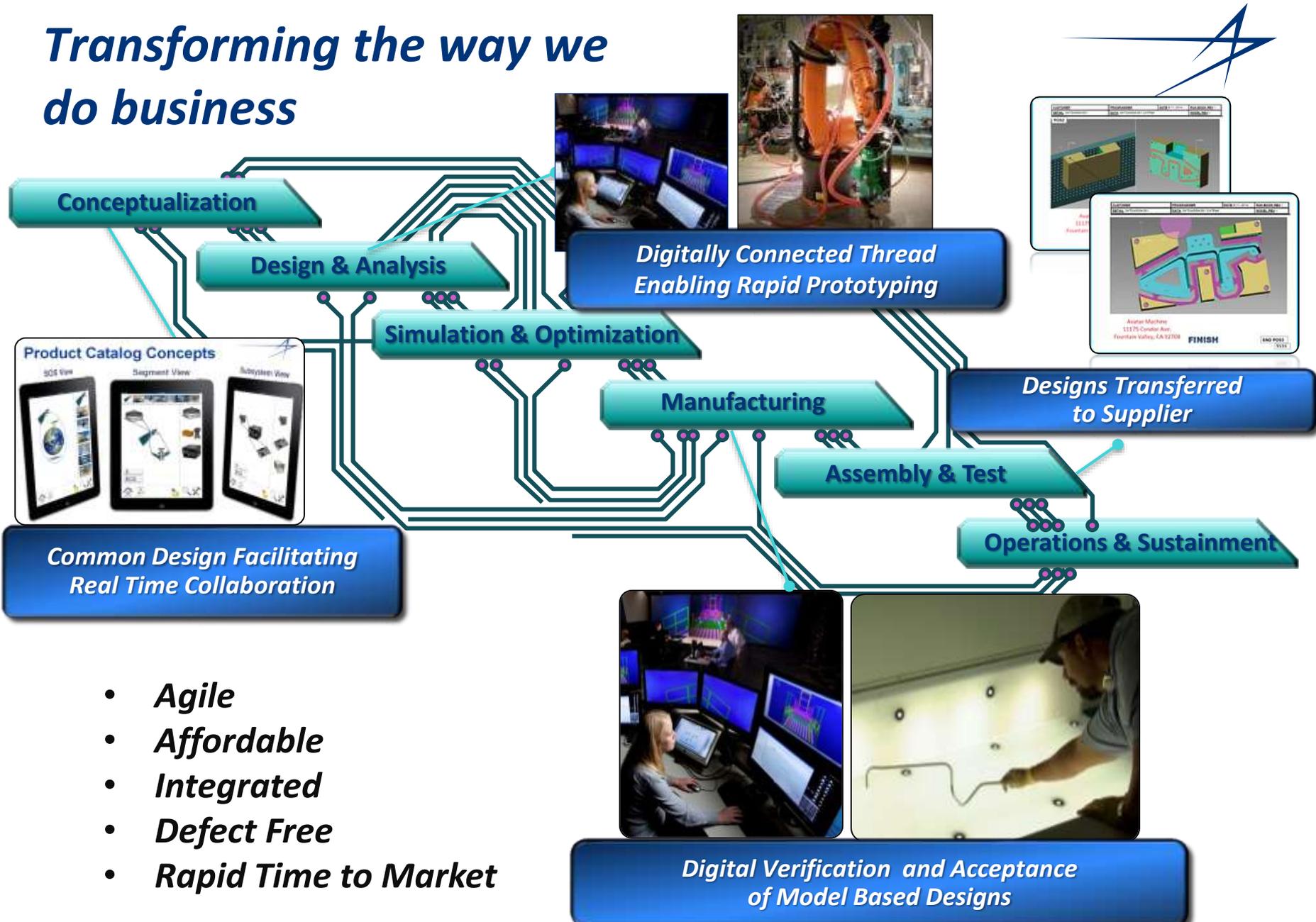


Jeanne Kerr
Director

Strategic Quality Management

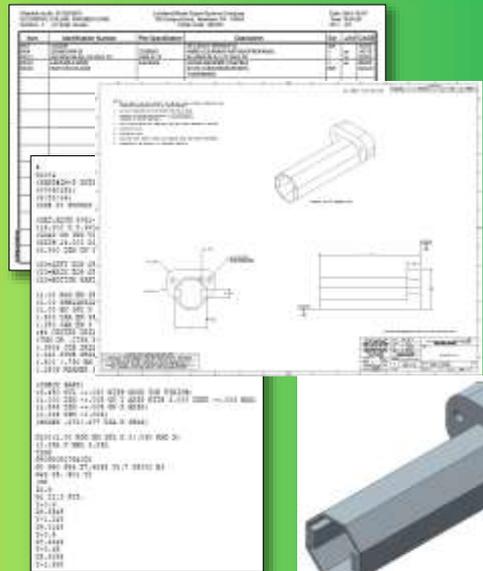
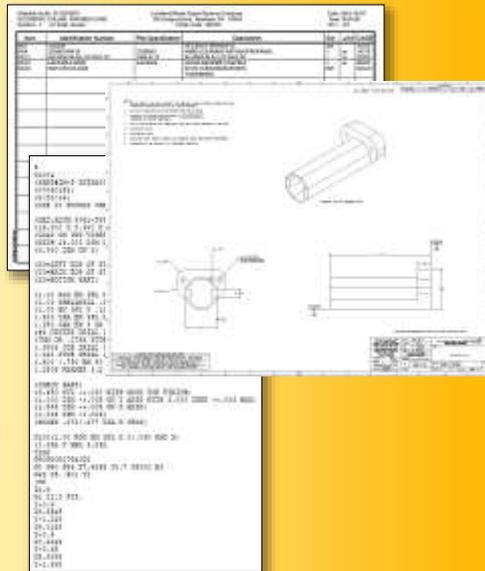


Transforming the way we do business



- **Agile**
- **Affordable**
- **Integrated**
- **Defect Free**
- **Rapid Time to Market**

Evolution of The 3D PDF



**2D Drawing and Step File
Design Revisions Require
Extensive Coordination**

**2D Drawing and Step File
3D CAD File Provided
“For Reference Only”**

**Digitally Linked Requirements
throughout Life Cycle
3D CAD File Becomes
“Record of Authority”**

Past

Present

Future

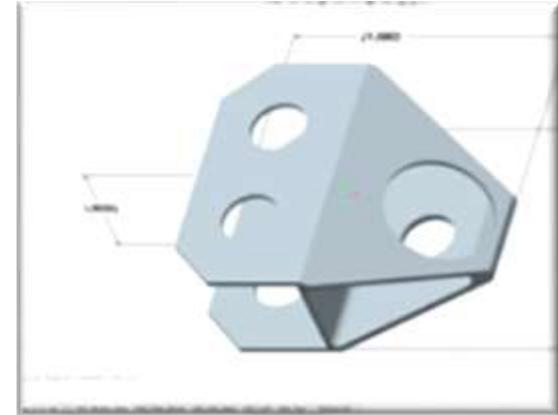
Digitizing the Supply Chain

Quality Assurance Digital Environment Vision



- **Strategic collaboration**

- Design Engineering
- Quality Assurance
- Manufacturing
- Supply Chain



Digital Model Example

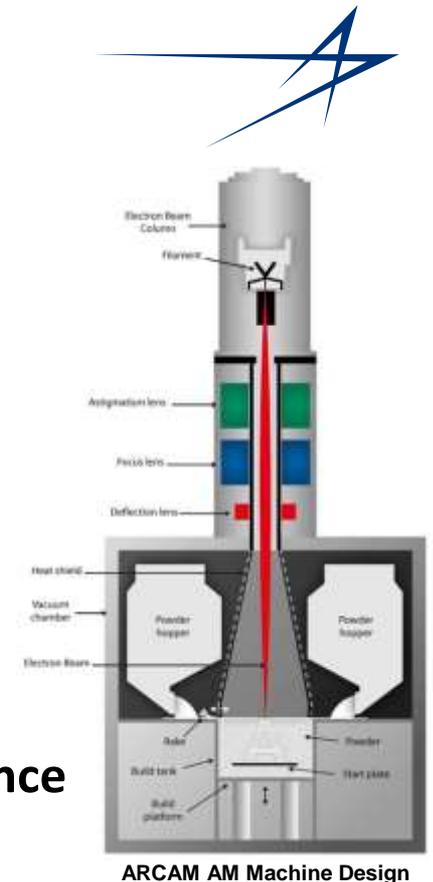
- **Leverage digital environment capabilities**

- 3D digital model design
- Additive Manufacturing (AM) technologies
- 3D digital verification/inspection technologies

Collaboratively Focused on Key Digital Tapestry Components

Digital Environment Initiatives

- **3D Digital Model Design**
 - Model design verification with Engineering
 - Model use verification in Manufacturing
 - Model use verification with Supply Chain
- **Additive Manufacturing (AM)**
 - Supplier AM process pilots and product acceptance
 - Manufacturing AM process pilots and product acceptance
- **3D Digital Verification/Inspection**
 - “As Built” 3D Scan digital model comparison to “As Designed” model
 - “As will be Built” digital simulation comparison to “As Designed” model



Full Digital Tapestry Thread: Design, Manufacture, and Acceptance

Quality Assurance Digital Environment Status



- **3D Digital Model Design**

- Piloted and rolled out Digital access
- Piloting Native vs Derived verification analysis
- Supply Chain: 3D PDF piloted with 4 suppliers



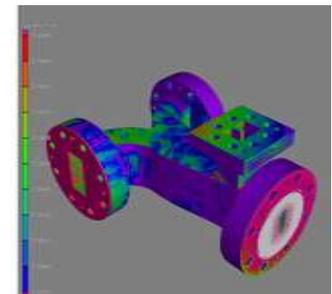
SSC ARCAM AM Part

- **Additive Manufacturing (AM)**

- 4 Suppliers piloted process and delivered accepted AM part

- **3D Digital Verification/Inspection**

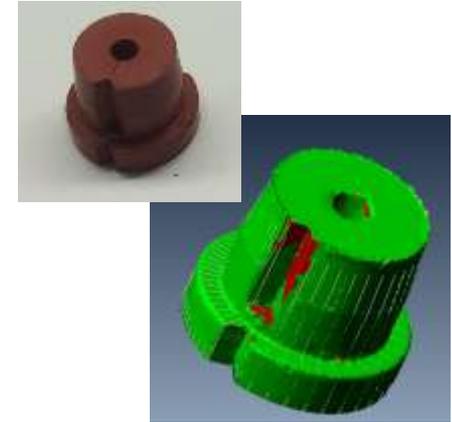
- Piloted White Light 3D Scan with Supplier
- Piloting 3D Scanning technology and Inspection in LM Factories





Pilot Focus on 3D Scan Acceptance

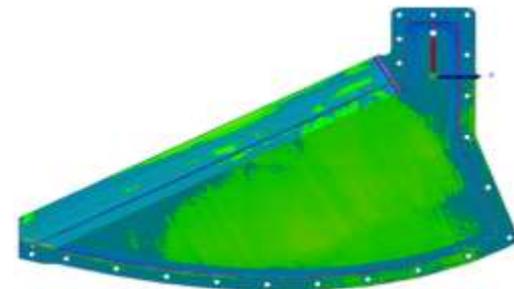
- 3D Scan Digital Acceptance verifies a digital model design with measurements from a 3D Scan of a part
- 3D Scan consists of 1 – 5 million measurements
- Equipment overlays the “as designed” digital model with the “as built” digital scan
- Graphic Heat map and detailed tolerance reports are automatically generated



FeatureTree by type: mm

Root: Alignment | Alignment group (1) | Alignment | Alignment group (2) | Alignment | Feature

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Total Savings: Approximately ~8 hours touch labor

Digital Design Transition



- **Background**

- Designers transitioning from paper drawings being the record of authority for the designs, to digital models being the record of authority
- Training created to show how to access the digital model to get the information normally received from drawings

- **3D Digital Model Training**

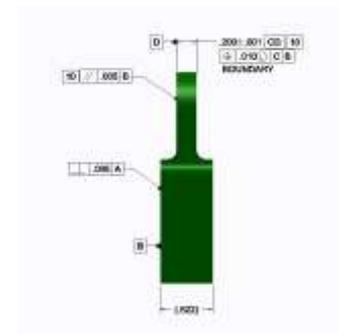
- How to Navigate Digital Models
- Navigate Model Views and Access Dimensions

- **Supplemental Video Tutorials**

- Navigating Digital Models
- Navigating and Manipulating Model Views

- **Access**

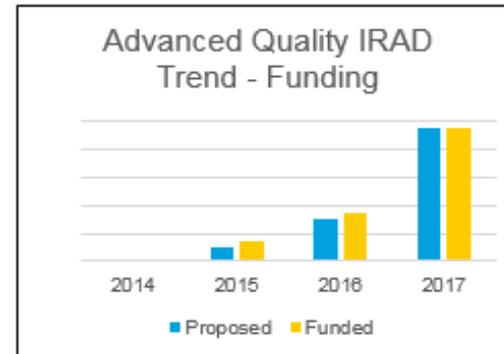
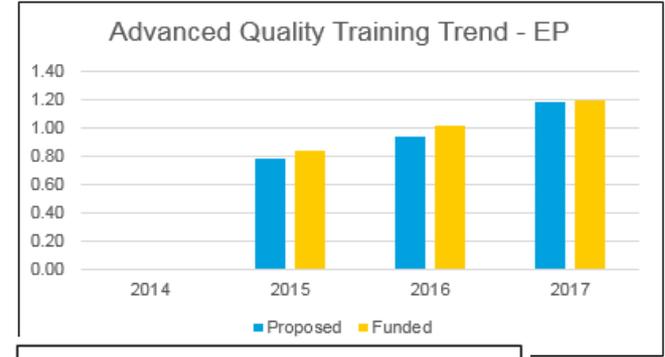
- Customer can request access through Program Offices



Model with Dimensions

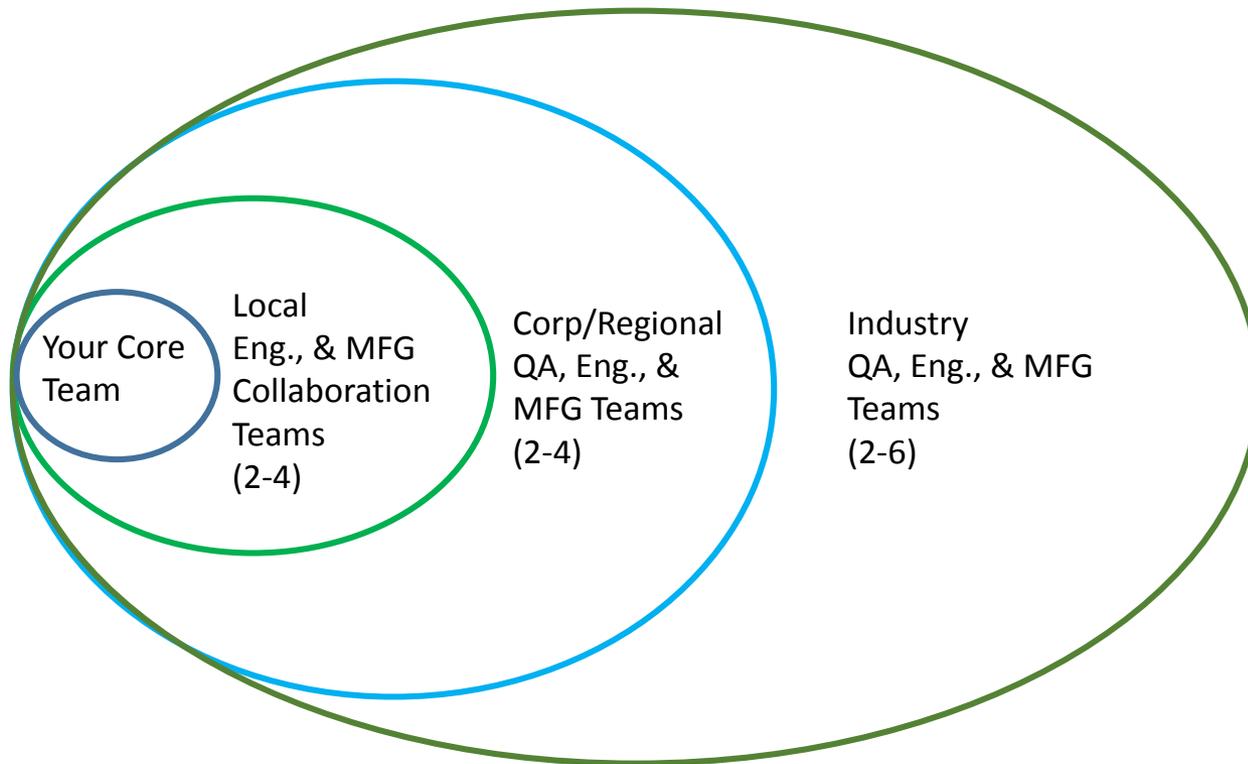
Building A Digital Tapestry Team – Lessons Learned

- critical first steps
 - Create a Simple Clear vision
 - Select a Collaborative team
 - Technical
 - Motivated
 - Forward Looking
 - Focus on 1-3 key areas
 - Manage the tasks like a project
 - Frequent kill or continue milestones
 - Communicate, Communicate, Communicate
 - Be prepared for opportunities
 - Celebrate Successes



Funding	2016 (EP)	Est. 2017 (EP)
SC/OH	3.7	4.5
Training	0.75	0.9
IRAD	0.75	2.0
Program	0.2	0.4
Total	5.4	7.8

A Collaborative Team

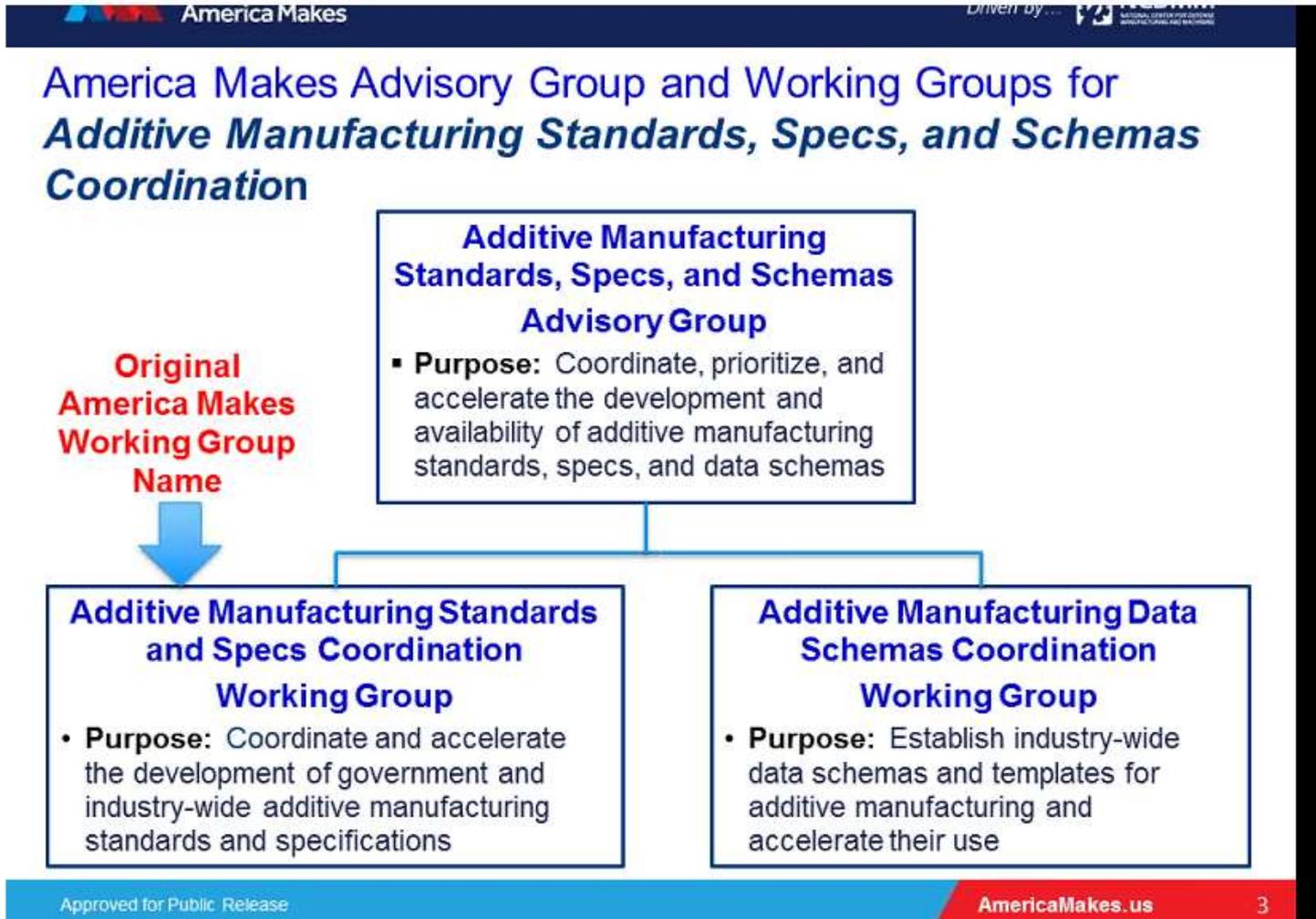


Share Knowledge, Initiatives, and Learning

2016 Technology Conferences Examples

- ✓ RAPID: AM/3D Printing and scanning
- ✓ ASPE: American Society for Precision Engineering
 - Dimensional Accuracy and Surface Finish in Additive Manufacturing
- ✓ IMTS: International MFG and Technology
 - MFG requested QA attend, advanced CMM programming, 3D Scan, etc.
- ✓ America Makes AM Standards Collaboration
 - Industry AM Standard Development Coordination
- ✓ NASA Additive MFG Conference
 - In Situ Monitoring as well as full AM lifecycle discussions

Additive Manufacturing Standardization Collaborative (AMSC)



AMSC Advisory Group established for Additive Manufacturing

Transforming with Next Gen Technologies



Ready for Weld



Post Test



Several years of propulsion tank dome forgings produced in 6 months

